# Sanitation

by Robert Lynn McAlpine

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A Graduation Thesis
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"Health is wealth;" "Cleanliness is next to Godliness;" "A Sale Cobbler is better than a sick King." These sayings are too true to need proof. They are self evident, yet man does not realize them. An inspection of a large tenement house in a thickly populated city displays this fact in all its revolting details. From thickly crowded apartments, the inmates stream forth and deposit slops and all manner of filth into a common basin. From this basin emminate gases, of unbearable odorss, which on account of their high specific gravity, cannot rise but a few feet above the house tops, (the pure air of Heaven seems to receive them) and they float over the troubled city like

a curse. They are blown hither and thither by the winds, ~~by the waters~~, into open windows and doors, spreading disease and death where ever they go. The fumes of hell can be no worse. What does not pass away from these filth reservoirs in the form of gases, goes down into the soil in the form of liquids, carrying with it living organisms of disease. These find their way into wells and cisterns, and are a source of sickness and discomfort. It is rather unpleasant to even think of drinking water from a well in close proximity to a privy. Still it is done and the water is contaminated with filth coming from the privy.
How often do we hear men say that all diseases are the curses heaped upon humanity for the sin committed by Mother Eve? How often do we read

resolutions extolling the virtues of a deceased member of some brotherhood, in which an "all wise Providence" is charged with his removal from earth; while the immediate cause of his death was a leaky house drain, a stagnant pool or a pestiferous privy.

The man who tells me that the yearly death of countless numbers of children and infants, who have never known sin, is a retribution for the sin of the mother of the human race, I pronounce a bigoted fool and advise him to inspect his privy vault and well lest he go pre-maturly himself.

Dr. Henry MacCormac says:- "We live or die, live well or miserably, live our full term or perish prematurly, accordingly as we shall wisely or otherwise determine."

Dr. Richardson says:- "These diseases

need not be looked upon as necessities of existance, but may be recognised as results of ignorance, or as accidents which are preventable by accurate foreseeing and all providing "knowledge."
Dr. George Derby says:— "The well are made sick and the sick are made worse for the simple lack of God's pure air and water."
Hippocrates gave us the fundimental principle of health:— "Pure air, pure water and pure soil" and we after all these centuries know nothing to add to it.
Deseases is due to an unnatural condition of living — to neglect, abuse or want.
The germ theory of deseases is accepted by all prominant physicians now living. The germs are carried into the system through the air, through the water or through

the food. There they breed by millions, only to go forth to other unfortunate individuals. Typhoid fever which yearly counts its victims by thousands, has been traced to a preventable cause. Dr. John Simmons, Health Officer of London, in one of his reports said:— "It has been discovered that the cause of typhoid fever is a germ as specific as that which causes small pox; a microscopic form, apparently of the lowest vegetable life, either breathed or drank, multiplying to innumerable swarms in the intestinal tissues, and spreading from the mucous surface by millions, in every portion of the system"

Diphtheria is another desease of the same kind. Dr. Wight, Health Officer of Detroit, says:— "The gaseous emanations of filth, of organic matter in process of decomposi-

tion is the very breath of life of diptheria.
And so with scarlet fever, neuralgia, dysentry, erysipelas, small pox and worst of all yellow fever and Asiatic colera.
Thousands of the worlds population are annually swept away by these deseases, and still the plagues linger. The patient leaves the seeds of the desease in excrements; they pass into wells or directly through the air, to the neighbors family and so the work of destruction goes on.
Advancing science has shown that all these deseases are propagated by germs and that these infinitesimal organisms make their home in filth of any kind, there to multiply a million fold.
We are accustomed to look upon war as very destructive; roll up our eyes and stand ~~aand~~ aghast when we contemplate its horrors. England in twenty

two years of continuous war lost 79700 lives while cholera in a single year carried off 144000. The mortality during the five years of our late civil war reached the appalling total of 500000 and the nation pays tribute every year to her fallen sons. Within the past five years it has been estimated that no less than 800000 lives of persons who were or would have been just as brave, just as loyal and just as well meaning as the "boys in blue," have been swept away by diseases which are absolutely preventable. They are laid away with a tear and a flower and are soon forgotten. It has been estimated that where one person dies, twenty fall sick (Playfair the eminent statistician places the number at twenty eight). According to this, in the United States, the health of at least 16000000

people is injured by preventable de-
seases every five years. These are the
ones who will go when the pleagues come
around again.

To turn the argument so that it will be
better understood by some of our more
influencial citizens, note the following.
It has been estimated that a case of
sickness represents a loss of fifty dol-
lars to the community. The direct pec-
uniary loss, then, to this country, on ac-
count of preventable sickness has been
in the past five years $800 000 000. Need I
sum up the undertakers bills for those
who die?

These may seem enormous and exagerated
figures, but I have the facts and author-
ities to prove my estimates; among whom
are Waring, Kellyer, Staley, Pierson and
the American Sewer Pipe Company. The

last named takes great pains in hunting up statistics of this kind. Whatever these figures are, it is enough to say that the loss to the community resulting from the effects of past sickness, the breaking down of constitutions, the decrease of bodily and mental strength and the consequent lessening of producing power, is very great and well nigh inestimable or incomprehensible.

It naturally follows that any expenditure of public money for the improvement of the sanitary condition of our cities and towns will be repaid, perhaps a hundred fold, in the increased health and the increased producing power of the community. "The estimated money value of sanitary works is capital invested at interest; triply or quadruply compounded"

It has been proven beyond any possibility of doubt that the construction of modern systems of water works and sewerage is in every case followed by a lowering of the death rate and in some cases by the almost total disappearance of zymotic diseases. In twelve towns in England, varying from 8000 to 68000 of inhabitants, the average death rate was reduced 47⅔ per cent by the introduction of systems of sewerage. Two hundred years ago the death rate of London was eighty per thousand; under the influence of sanitary improvement it has now been reduced to twenty per thousand, in spite of the enormous growth of the city and the great crowding to which many of its people are still subjected. In 1860 the city of St. Louis had a population of 175000 and a death rate of 32 per thousand. In 1865 they began the construct-

ion of a system of sewers. In 1870 the population was 310864 and the number of deaths 6670. The average population during the next four years was 325000 and the average number of deaths per year 6400, which would give a death rate of 20 per thousand. In other words St. Louis, without sewers, had a death rate of 32 per thousand and with sewers a death rate of 20 per thousand. From 1870 to 1874 there was an annual saving of 3900 lives or for the four years 15000 of the city's population. These are not isolated cases, but are the universal result wherever sanitary works have been instituted and properly constructed.

Again! "Looking at England as a whole we see that of each one hundred persons who die, not quite ten have reached the standard old age of seventy five years; and

that of each one hundred children born, hardly seventy four complete five years of life."

What then are we to do? Let us seek what nature does. What does man do when he hears the rattle of the poisonous rattle snake? He flies from it as fast as his legs can carry him. What does the dog do when food is offered him? He smells of it on all sides. If he scents putrefaction in it he leaves it in disgust. From this it would seem that we should run from all filth which is tainted with disease. But this would be erroneous; for if all did this each would soon run on to that from which others had just flown. The only other alternative is for a number to combine and have their filth removed from the vesinity of their habitation, by some

force of nature, — to a common place of deposit, which place other people may steer clear; or a better way still is to institute a means of purification. We are by our nature bound to have filth and must put with it in some way or other. The best way to do it in the case of a city is to construct a system of sewers.

The three results which a sanitary engineer seeks were concisely expressed by the noted Hipocrates, in his phrase "pure air, pure water and pure soil". These are afforded in abundance by nature and all that an engineer has to do is to remove the filth which contaminates these three essentials. The remedy lies in filling up the stagnant pools, inaugurating a complete and thorough scavenger and the efficient draining of the locality with

and about our dwellings and places of business. This is what has been done for ages but it is only within the last few years that Sanitary science has been brought to any state of perfection. In this enlightened nineteenth century we are only reviving a lost art. "Alexandria Carthage, Herculaneum, Nineveh, Rome and many other ancient ~~[illegible]~~ cities had complete systems of water works and sewers". Twenty five centuries ago Rome in the height of her pomp and glory constructed her famous Cloaca Maxima, by means of which a great part of the filth of the city was conveyed into the Tiber. To day the Cloacae still perform the duties for which they were originally intended.

The sanitation of a community consists

them of three acts — the filling up of the cesspools, the construction of a thorough scavenger, or in other words a system of water works, and the complete drainage of the locality, including the removal of all filth. Each is a separate problem. It is of the last that I shall speak at length.

The drainage question in the construction of a system of sewerage is divided into three parts — the drainage of the surface, the drainage of the sub-soil and the carrying speedily away of all foul matter discharged from the kitchen sink, bath tub and water closet, to a place of safety before decomposition has commenced. The last is the most important of the three from a sanitary point of view, and the most difficult to perform.

The drainage of the surface has to do with the rainfall. Its object is to do away with all stagnant pools and to reduce to a minimum the inconveniences and damages of storm waters.

The sub-soil drainage is not always needed but the importance of it is sometimes not fully appreciated. It is a well known fact that wet soils, breed malaria and consumption and the only means of preventing such diseases is good drainage. A system of sub soil drainage is sometimes instituted to prevent the undermining of the conduits, which carry the other waters. The best way of draining the sub-soil is to lay a system of porous pipes, surround the pipes with coarse sand and refill. The water will pass through

the pores and off through the pipes.
There have been many plans proposed for the removal and destruction or purification of all nasties and foul matters. Fire, earth, air and water have been used with varying degrees of success. Fire has been proposed as a means of rapidly oxidising the matters; or doing quickly what nature does in the long run. The "direct removal" or "pail system" consists in having the filth deposited in large pails which are emptied at regular intervals.
Earth is used to deodorise and fix the elements of decomposition so as to render the matter so harmless that the whole can be removed by hand without danger, and used as manure.
Air is used in what is called the "Pneumatic System". The principle is to draw

to a central reservoir all the accumulation of sewage deposited at the separate houses. The reservoir is exausted of air by powerful engines and the accumulations are drawn to it by pneumatic pressure. There they are destroyed or removed as best seem fit. The objection to this system is the expense involved in construction and the keeping in working order.

The "water carrying system" is held by many to be the most feasible plan which can be addopted in an average town. In this system pipes are laid beneath the surface which convey dissolved or suspended in water, all sewage, to an outlet beyond the limits of the city. This is the plan addopted by most cities and when properly constructed serves admirably. But

on the other hand when poorly constructed it is a very hot-bed of disease. "An imperfect sewer has been very properly called a retort for the manufacture of sewer gases, which are admitted into every house by an ingenious system of pipes delivering an intermittant supply through every sink, water closet, bath tub, wates basin and producing its annual crop of zymonatic (Zymotic?) diseases." So in laying conduits for a sewer, great care must be taken and each point well studied and decided upon before work is begun

The water carrying system is itself divided into two systems — The "Combined System" and the "Seperate System". In the combined system there is no surface drainage, or rather, the

rain water and sewage are carried in the same conduit. In the seperate system the rain water is taken care of on the surface and not allowed to go into the sewer, except in certain cases. There are a great many objections to the combined system; some of which are so serious, as to lead one at first to discard it all together. But the combined system has been used in so many cases and has served so admirably that it has many staunch supporters. The same however can be said of the seperate system and in the average town it is undoubtedly the best. It is the cheapest by far and has not the objections which the combined system has.

An ideal sewer is one in which all of the sewage is carried rapidly to the

outlet before decomposition has begun. It should be smooth, impervious to water and water tight at every joint. It should be able to be flushed at regular intervals, so as to prevent the formation of dams and deposits and thereby check the generation of any considerable amount of sewer gas. It should be well ventilated so that when sewer gas was unavoidably developed it would not find its way back through the pipes into the houses, but escape into the air. It should have ample means for inspection and repair. It should require the least amount of attention and care.

The ~~Separate~~ Combined system does not always possess all these qualities, and sometimes does not to such a degree as to render it undesirable. In designing sewers for this system the size will be determined

by the amount of rainfall. The amount of sewage to be provided for is so small compared with the amount of rainfall as to hardly enter into the calculation. But the sewer must be designed so as to carry a maximum volume of sewage during a time of greatest rainfall.
It can be plainly seen that the sewer must necessarily be large; and being large it must have a small grade in order to reduce the velocity; for a large mass of water going at a high rate of speed represents considerable force and requires something unusual to resist it. This would require the sewer to be built heavy or thick which means great expense. On the other hand reducing the velocity lengthens the time of removal and at the outset we desired as rapid removal as possible. Though the sewage will be

but a trickling stream in such large
conduits
~~sewers~~, yet when the storm water comes
the conduits are quite efficiently flushed.
Then again, the storm waters may come
so irregularly as to allow a great amount
accumulation to take place, during
the intervals, which might generate
a great amount of sewer gas.
At the street corners are placed "catch
basins", in the combined system, which
open into the sewer at about half their
depth. In these basins the sand and
rubbish carried along by the currents of
rain water in the street are supposed
to settle; but the basin fills up so rapidly
that the dirt does not have time to
settle and consequently a considerable
amount of material is carried into
the sewer. The continual pouring in of
the rain water into the basin keeps the

water already in, in violent agitation and does not permit setteling. The sediment which passes into the sewer, there, on account of the slow velocity, settles to the bottom, accumulates, forms dams and perhaps before another rain or before the sewer is flushed, a large amount of sewage is held standing, which decomposes and forms great quantities of gas.

Sometimes they have been miscalculated and the sewers are not large enough to fulfill the purpose for which they are designed. I myself know of a case of this kind which happened in Kansas City. One of the street corners there (5th & Main Sts.) is right over an old hollow which has been filled up. It is the lowest point of the surrounding territory. A few years ago a

torrential rain fell; the sewer, which has an opening at the corner, was not able to accomadate it, and the water coming from all directions, fairly piled up. It ran over the side walks and into the cellars and ground floors of the buildings on both sides of the street. The sewers necessarily have to be made to accomadate the heaviest rains.

There are a great many other objections I could speak of, such as the difficulties of ventilation, of flushing, traps, connections, the care and attention constantly required &c. &c., but I will not take the space. To read one of the reports of Dr Wight, Health office of Detroit, to the city council, would lead an ignorant man to think that the combined system is one of the worst things on earth.

As said before the comparatively small cost of the seperate system* is one of its greatest recomendations. Its small size permits it to be laid at steep grade and makes flushing an easy matter. Its ventilation is easily obtained; in fact it does not need such ventilation as the combined system because there is less gas generated. Sewage is perfectly harmless until it begins to decompose into the sewer. The time between its entrance and the time it begins to decompose is the time which should be consumed in its removal to a place of destruction or purification. This time is generally not very long; hence the sewage must be carried rapidly. This can best be done with the seperate system. To flow rain waters on the surface is not an undesirable thing. The waters though sometimes

are their
dirty, ~~is~~ harmless and, ~~it~~ emptying into
a neighboring stream is not hurtful.
As said before, to empty them into the
the sewers requires the latter to be made
unnecessarily large. Only in large cities
where the water would need to run ~~in~~
long distances through the streets, would
any underground conduits for storm
waters be necessary. Where this is the
case, either a seperate channel may be
made or the sewer constructed suffic-
iently large to accomadate it.
The size of a sewer to accomadate a com-
munity is generally less than the average
person thinks. In the seperate system,
when the size does not exceed eighteen
inches, the sewers are made of vit-
rified clay tile pipe. When they exceed
that they are constructed of brick and
coated on the inside with hydraulic

ament.

The most effective means of ventilation in the seperate system is to carry a pipe from the untrapped house drains above the house tops.

There are many ingenious methods of flushing, the best probably being Van Vranken's siphon tank.

With whatever system is used there must be some way of disposal of the sewage. All chemical processes, so far, have failed. They produce clarification and not purification of the water. The way in which sewage is most usually disposed is to empty it into a neighboring stream of water. This is wrong from the very first. It is against moral law, and should be against civil law, to place those who live below the mouth of a sewer, in danger. It is held by

some that in an average river and with an ordinary amount of sewage, the water is not affected, in the least, eight miles below the mouth of the sewer, letting alone being harmless at a distance much less than that. On the other hand renowned scientists will tell you that the distance at which the effects of sewage can be noticed is unlimited; that the germs of cholera have been carried by rivers forty and fifty miles, in Europe and that is wrong to empty sewage into the rivers at any point. At any rate the question is unsettled.

Lets us turn our our attention for a moment to another thing. There are certain substances in the soil which make certain crops grow. Some of these substances are taken out of the soil

with each harvest. This is why the farmer manures his fields every year. He replaces these necessary elements. It is wrong then in at least one sense to empty sewage into our rivers. It contains the elements necessary to produce our food and and should be returned to where it came from, — the fields.
In some cities this is what is done. A pumping station is placed in the city to which all the sewers enter. The sewage is pumped five or six miles out into the country and there spread over the fields. On these fields monster crops of all kinds of eatable vegatation are grown. The returns from these crops more than pays the interest on the money invested in the works. When this plan is addopted,

and we must all admit that it is the right plan, the seperate system is the best. When we plan this method for the combined system we have to calculated machinery for pumping the heaviest rains, and which in ordinary times, will not be half in use.

The object of my paper has been to prove the need of sanitation and show the superiority of the Seperate System over any other.

R. L. McAlpine

(1887)

(My engineering thesis is a continuation of this; being the planing of a system of sewerage for the City of Lawrence)